Satellite and Aerial Imagery
Demonstration Project

USGS Topographic Digital Orthophoto Quadrangles (DOQ)

Bonneville Power Administration

Teasdale Environmental Associates, PLLC
P.O. Box 446, Genesee, ID 83832
ph/fx: (208)285-1637
email: teasdale@genesee-id.com

Gregg N. Teasdale, P.E.

September 2003

DIGITAL OROTHOPHOTO QUADRANGLES

Aerial photographs and digital images capture the spatial relationship of surface features in a manner that closely resembles the two dimensional depiction of cartographic maps. Aerial images are nearly unbiased observations when compared to the subjective interpretations embodied in cartographic products. Original aerial photographs do not have a uniform scale so cannot be measured like maps. Image distortion is primarily caused by lens optics, tilting of the camera and terrain relief (topography). Image processing techniques are employed to correct distortion to produce map-like images that have nearly uniform scale and retain the detail of the original images. The image correction or rectification process is called orthorectification and produces in an image commonly called an orthophotograph or orthoimage. Digital orthorectified aerial images produced by the USGS to match the coverage of the topographic quadrangle maps are call Digital Orthophoto Quadrangles (DOQ's).

DOQ's are an extremely useful and cost effective source of geospatial detail for Geographic Information Systems (GIS). Experienced analysts can extract an amazing amount of detail from aerial images. Users new to aerial imagery and GIS systems rapidly build skill in the interpretation of DOQ's because of their relatively high resolution and human scale perspective, especially if they are familiar with features in the coverage area.

OBJECTIVE

This tutorial will introduce USGS Digital Orthophoto Quadrangles of the area near Walla Walla and College Place, WA. We will use ArcView's GIS tools to explore and identify features in the DOQ's and compare theme to their cartographic representations on the corresponding Digital Raster Graphic (DRG) topographic maps.

Table of Contents

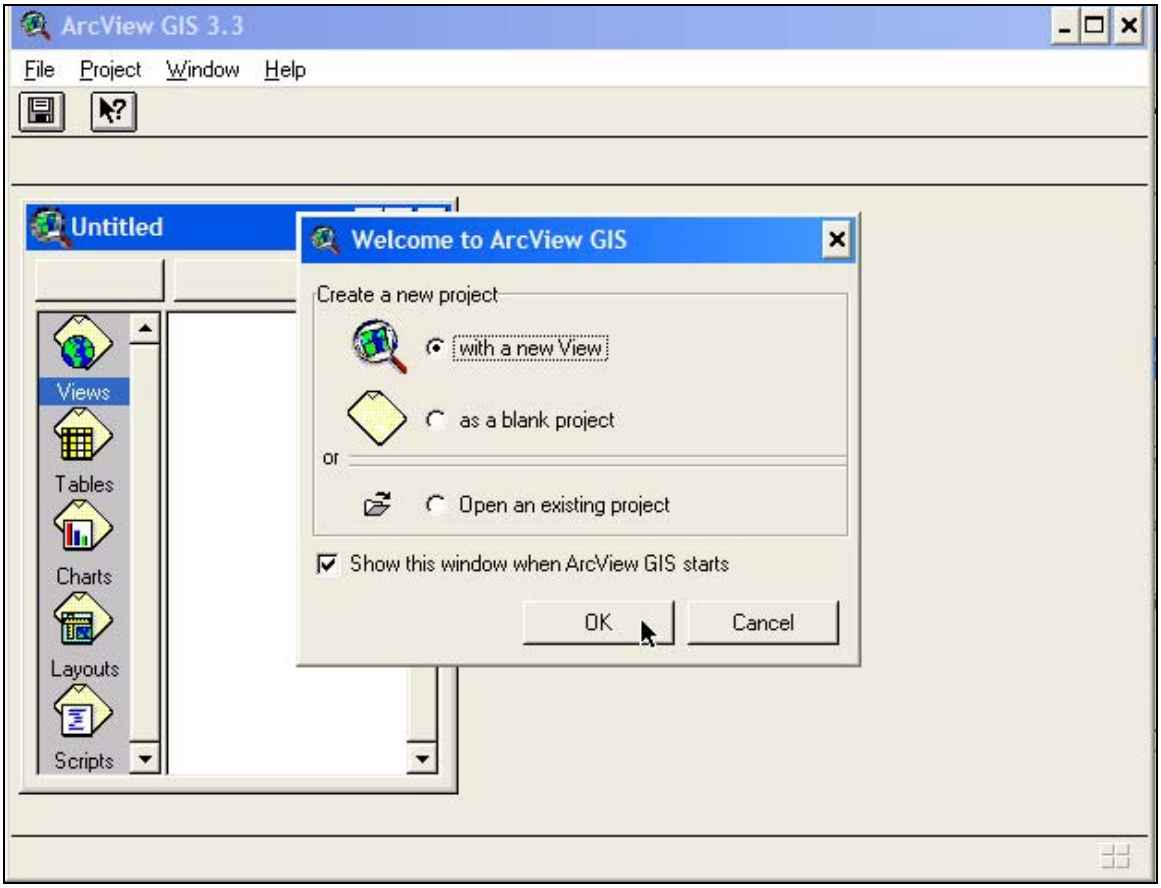
1. Open ArcView from the desktop shortcut. 4
2. Load the Walla Walla 250 K DRG 6
3. Save the ArcView project. 8
4. Set the View Properties 9
5. Load the Walla Walla 24K DRG 10
6. Load the Walla Walla NW DOQQ 12
7. Explore detail in the DOQQ 14
8. A DOQQ Mosaic 18
9. Load the College Place DOQQ's 21
10. Stream Channel Change 22
11. Land Use/Land Cover Classification 27

Answer to Exercises 34

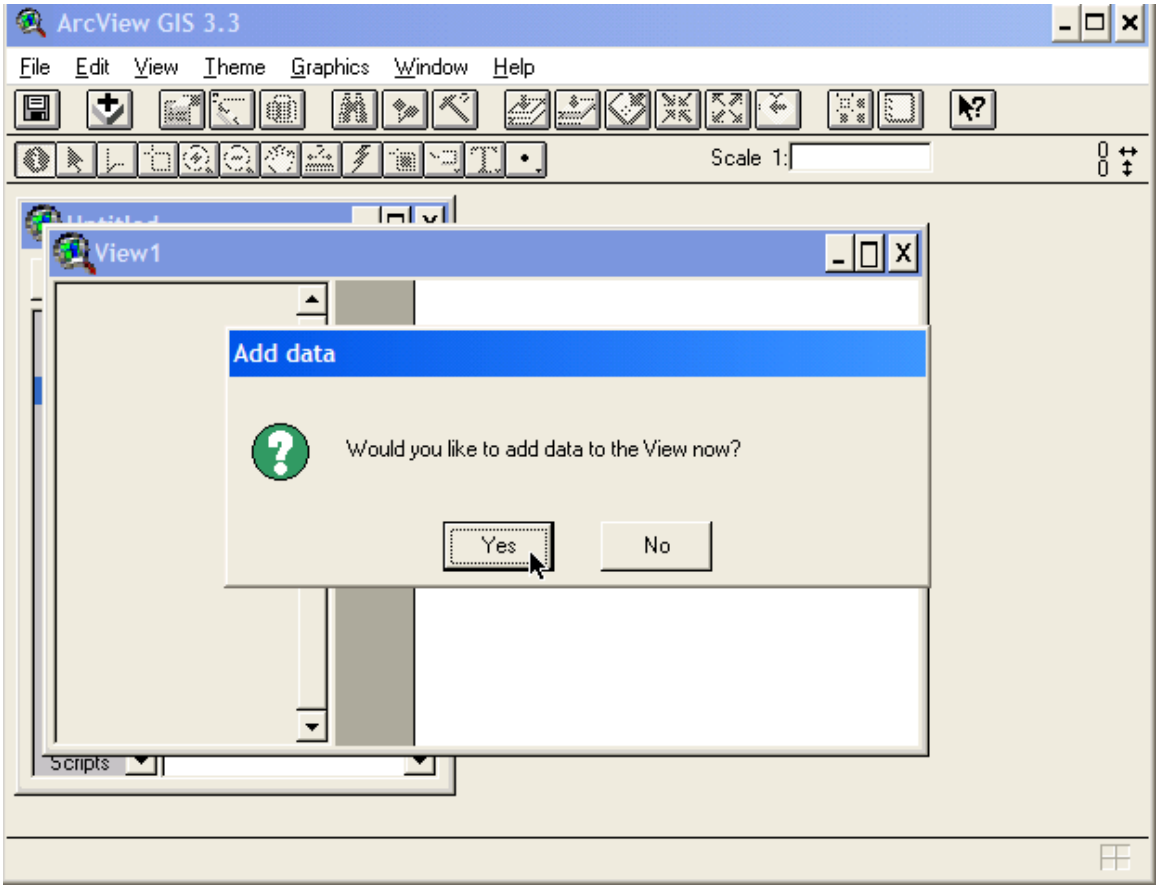
1. Open ArcView from the desktop shortcut.

Click on the shortcut icon to start ArcView.

The Welcome to ArcView dialog box presents the user with three choices. Select **Create a new project with a new View**. Click OK.

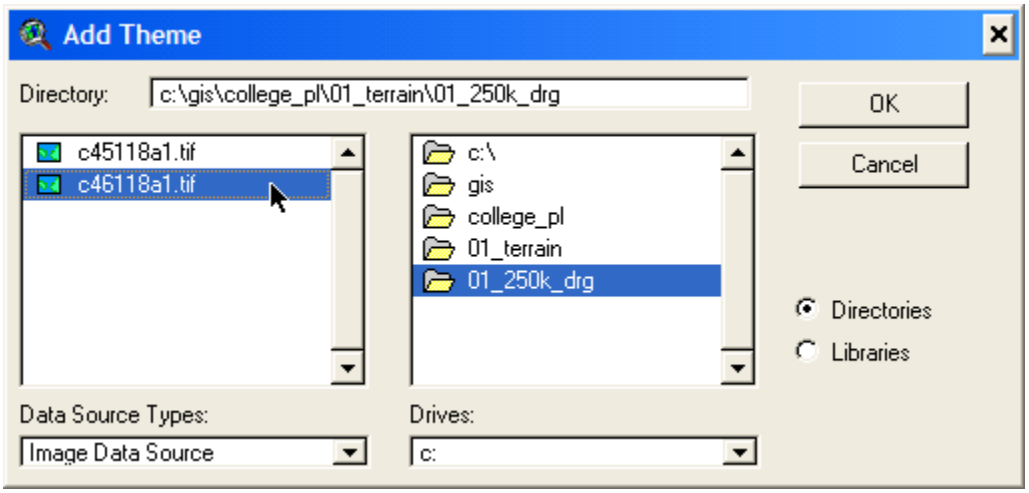


Click Yes in the Add data dialog box.



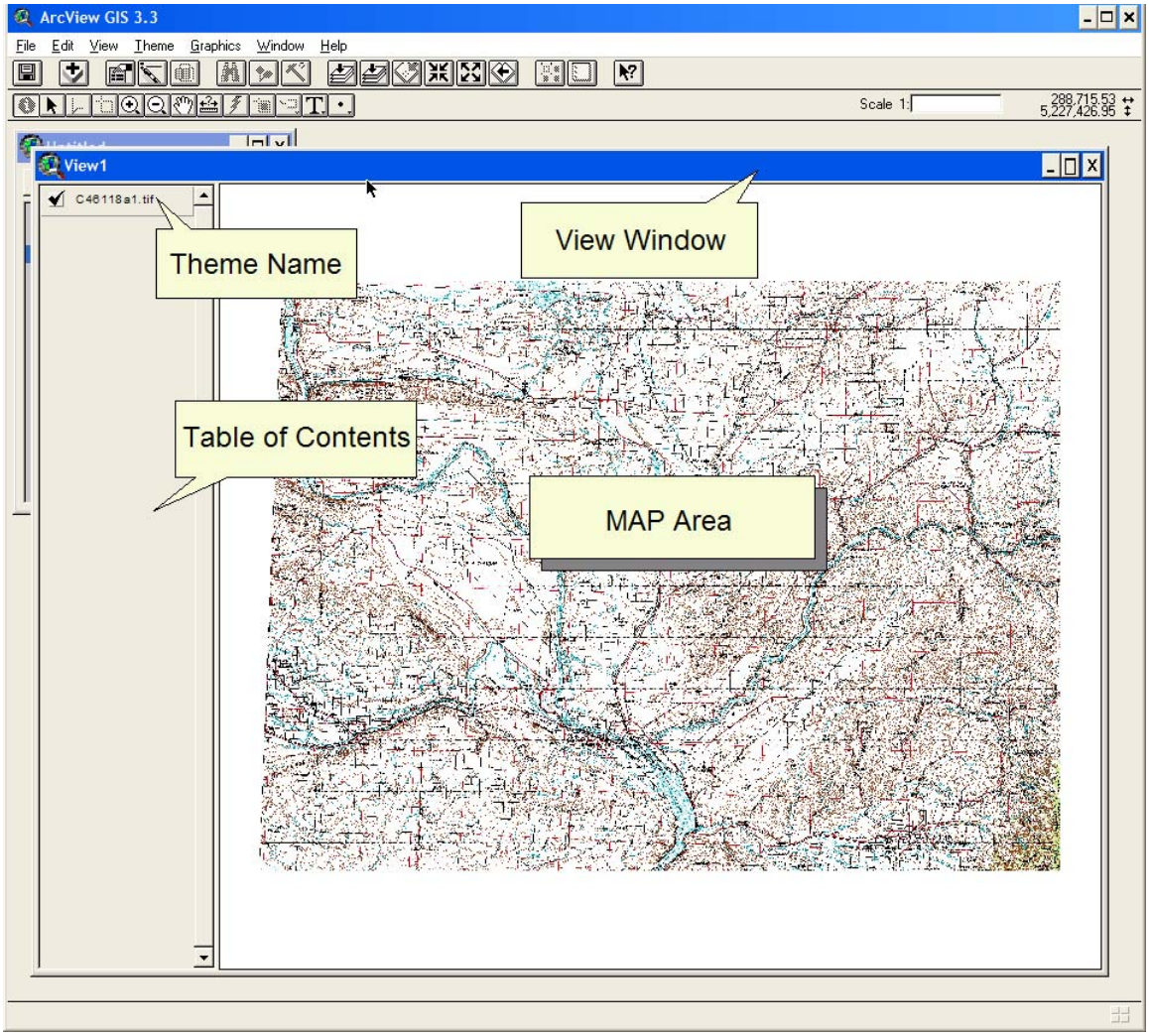
2. Load the Walla Walla 250 K DRG

Change the Data Source Type to **Image Data Source**. Navigate to the directory: C:\GIS\College_pl\01_Terrain\01_250K_DRG. Select the file c46118a1.tif. Click OK.



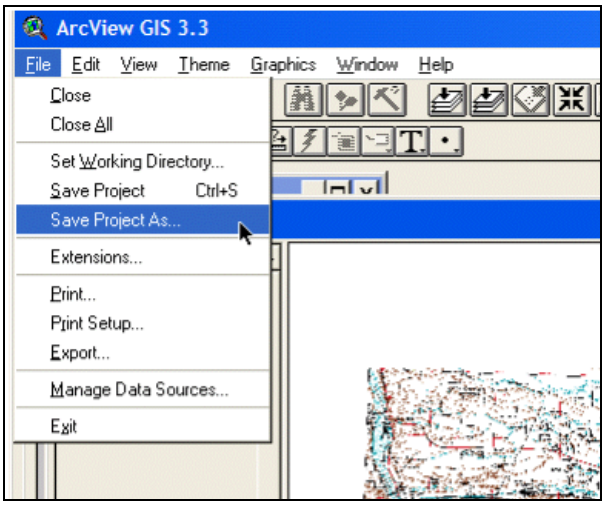
This map image is a scanned version of the 1:250,000 scale topographic map produced by the U.S. Geological Survey. Scanned topographic maps of all scales are called Digital Raster Graphics (DRG).

Click the check box on the theme (data layer) name in the view window table of contents to make the theme visible. See the image below to identify the various parts of the image.

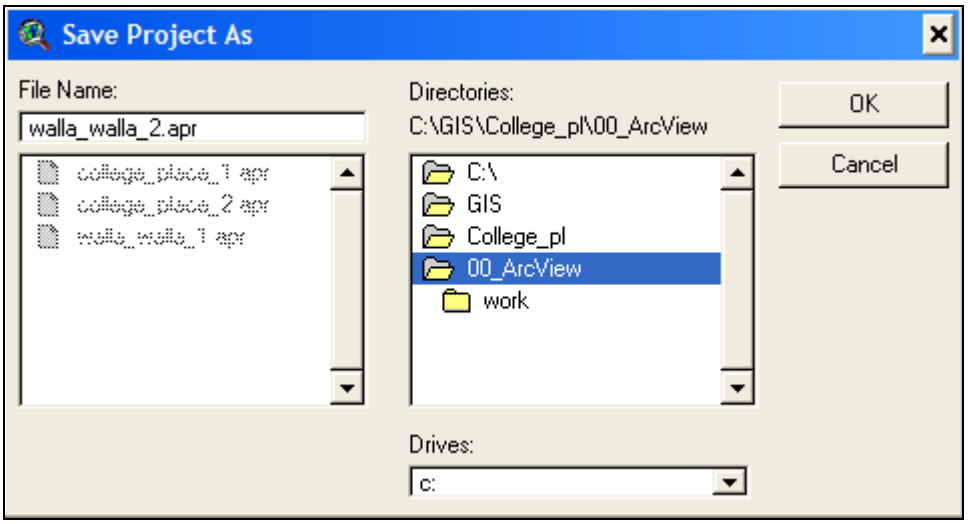


3. Save the ArcView project.

Select **Save Project As** under the File menu.

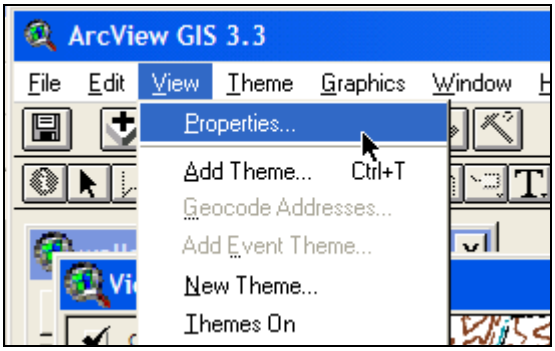


Navigate to a convenient directory, name and save the project. ArcView 3.3 project files have a *.apr extension. The ArcView project files does not have to be saved with a project's data files.

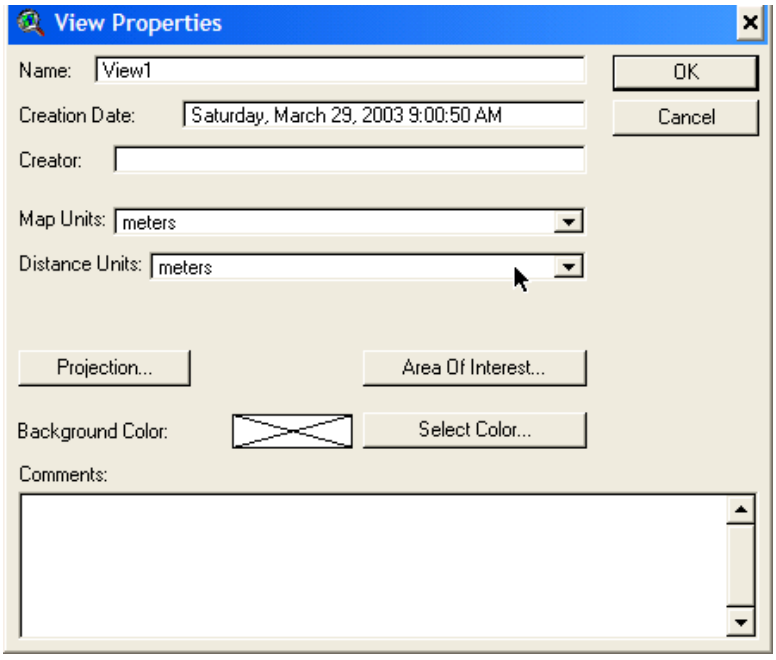


4. Set the View Properties

Select Properties under the View menu.

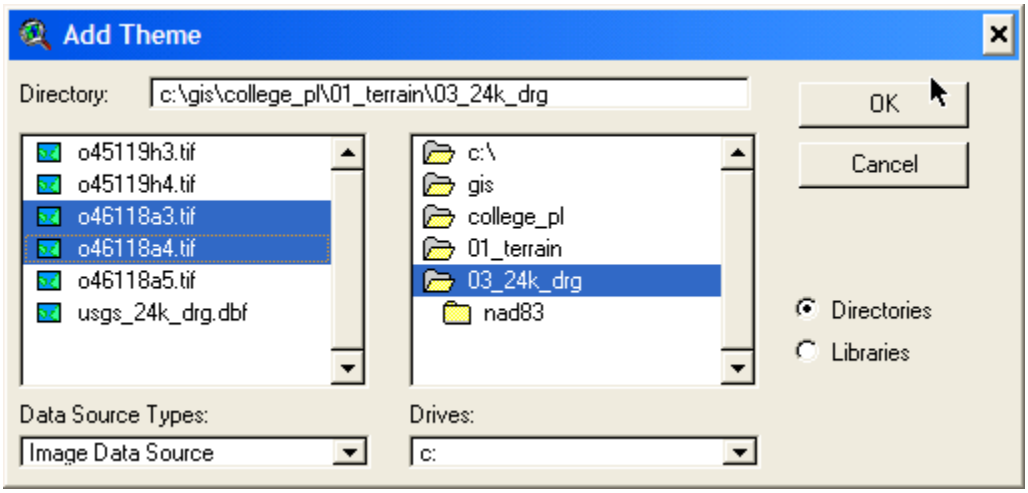


Options in the View Properties dialog can be set to define the units associated with the numeric coordinates of the projection. Most DRG's are projected according to the metric based Universal Transverse Mercator (UTM) system so the units are meters. Select meters in the Map Units pull down menu. Distance Units are set by the user and control the output of measurements made in the GIS view. Select **meters** in the pull down menu of Distance Units dialog. Click OK to return to the view window.

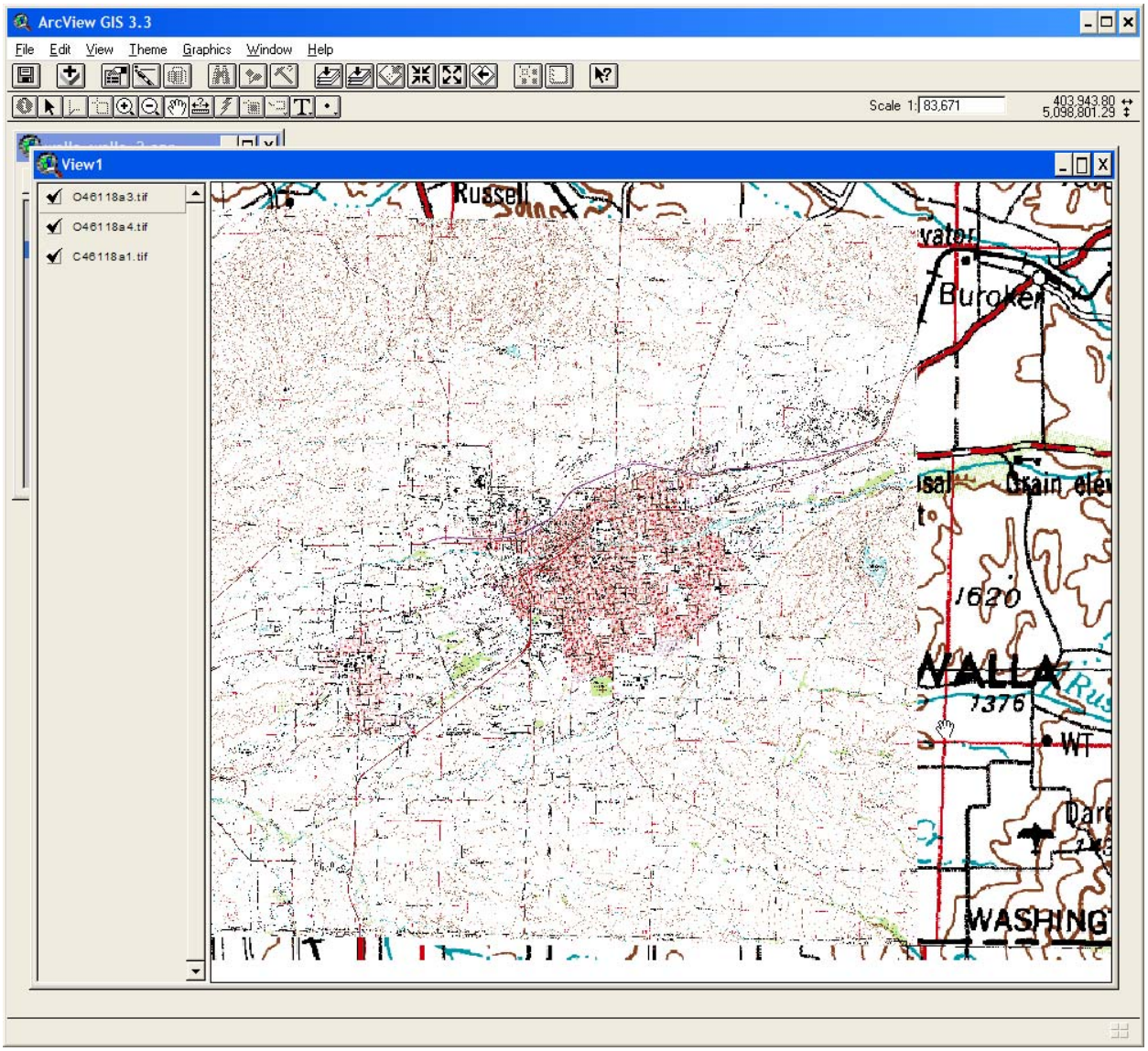


5. Load the Walla Walla 24K DRG

Click the Add Theme icon. Navigate to the directory C:\GIS\College_pl\01_Terrain\03_24K_DRG. Hold down the shift key and select the two 24K DRG's shown below.



Activate the theme O46118a3.tif and click the Zoom to Layer button.

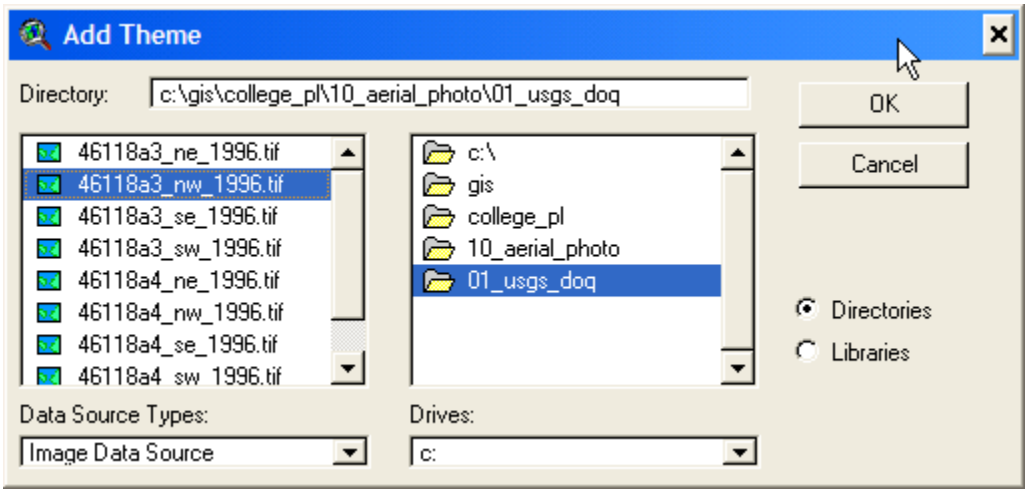


The USGS 24K DRG is the highest resolution (largest scale) topographic DRG routinely produced by USGS. It provides the highest level of detail. Features seen in 24K DRG's are usually interpreted and delineated directly from aerial photographs. The 24K DRG or its original 1:24,000 7.5 minute topographic quandrangle, often serve as primary base maps for other USGS map products. The 24K DRG's are an important source of historic land cover information. Use and interpretation of USGS 24K DRG's are discussed in a separate tutorial.

See the DRG tutorial for more information about DRG's. SAVE the project.

6. Load the Walla Walla NW DOQQ

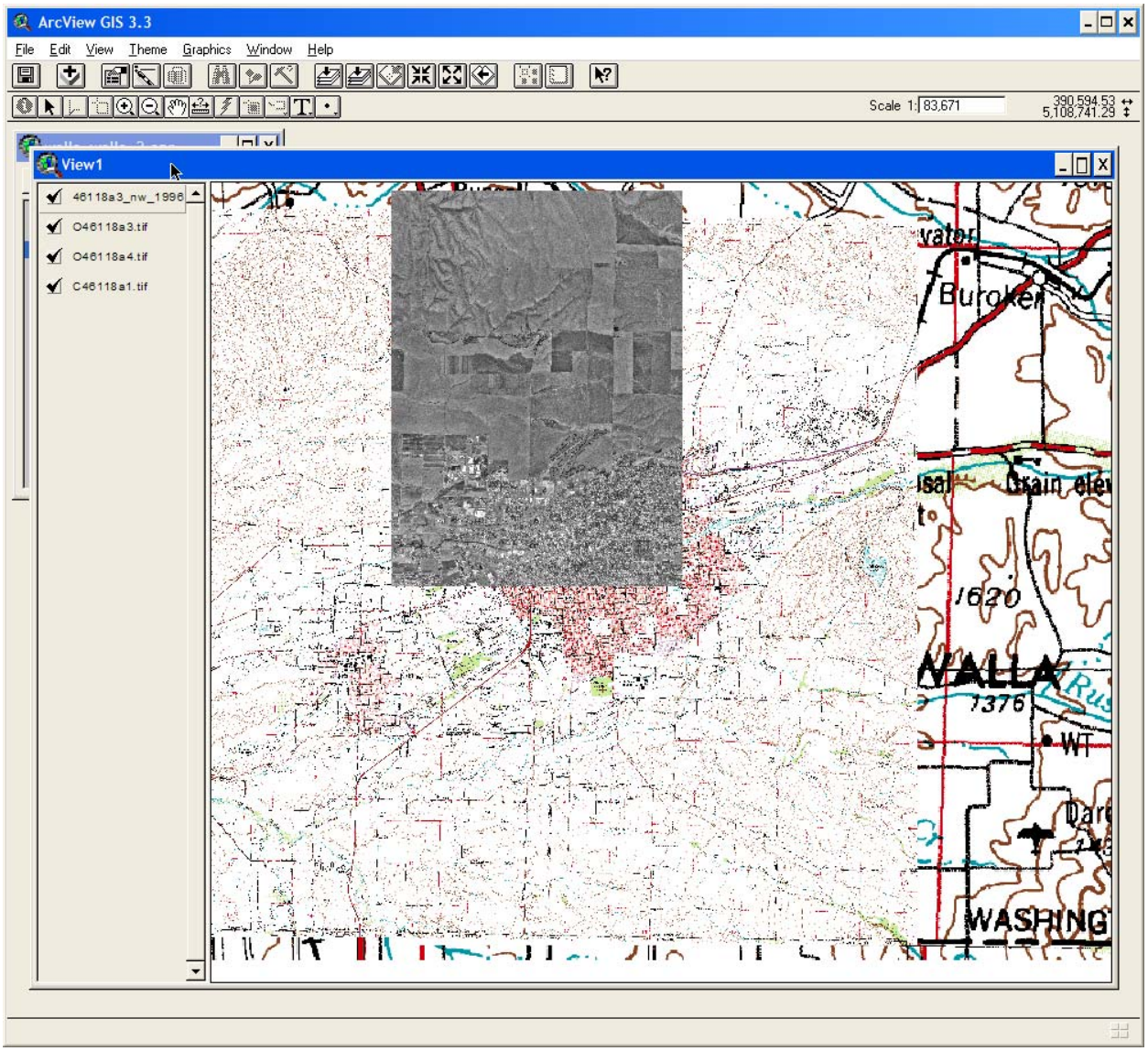
Click the Add Theme icon. Navigate to the directory C:\GIS\College_pl\10_Aerial_Photo\01_USGS_DOQ. Select the file 46118a3_nw_1996.tif.



Digital Orthophotos are scanned aerial photos that have been processed to remove terrain scale distortion and are georeferenced so they may be loaded into as an image theme into GIS. The most common digital orthophoto image product is the Digital Orthophoto Quadrangle (DOQ) produced by USGS. The USGS DOQ's have a ground pixel resolution of 1 meter. They give a high-resolution view of land surface details.

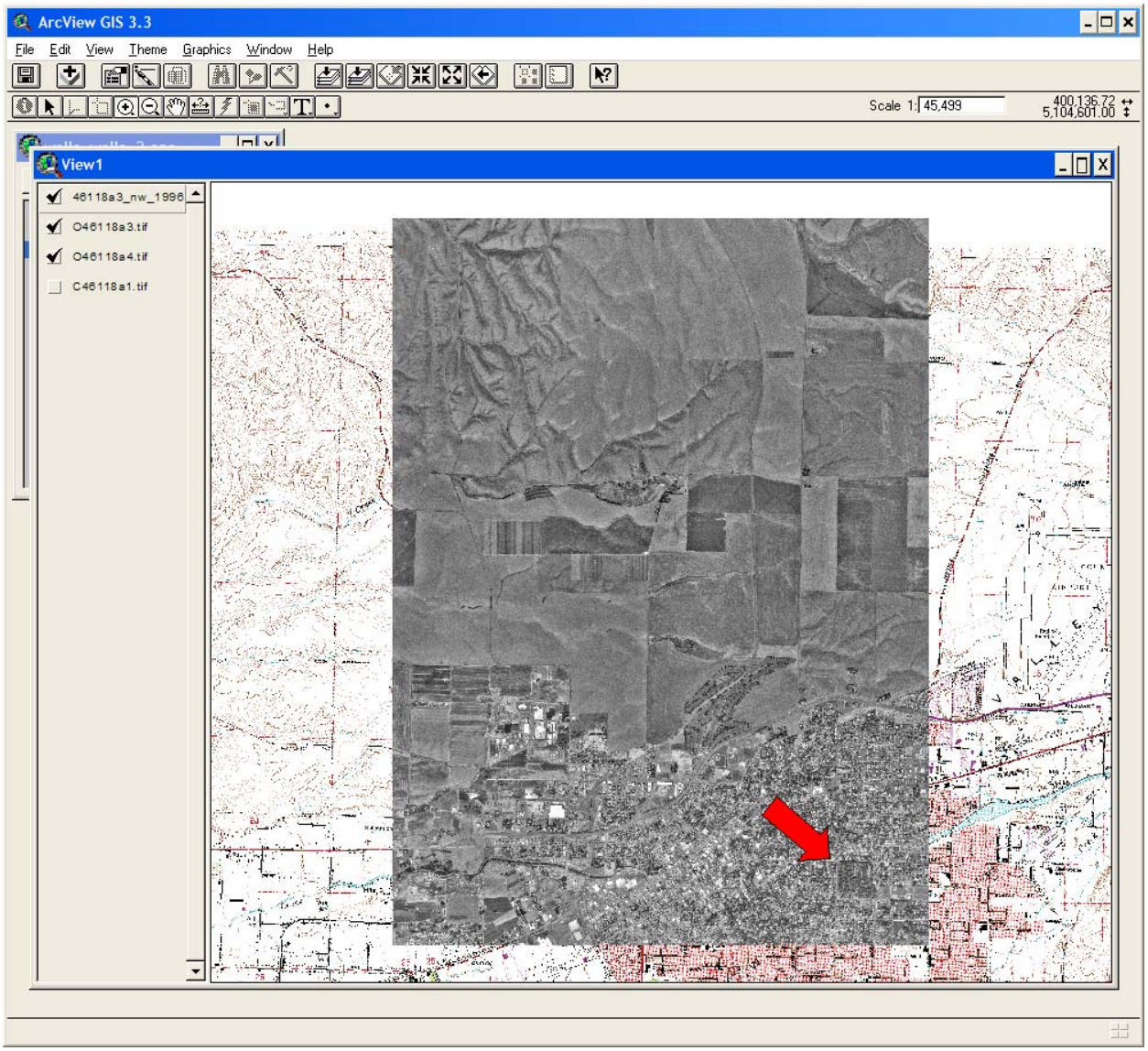
The most basic DOQ product developed by USGS is the Digital Orthophoto Quarterquadrangle (DOQQ). This keeps DOQ file size reasonable (about 34 mb) and is comparable to the coverage of the most common type of aerial photographs used in development of DOQ's. It takes four DOQQ's to cover the area of the 24K topographic quadrangle or DRG. DOQQ's may be indentified by the topographic quadrangle name and the compass quadrant they cover (ie NE, NW, SW, SE) or by an alphanumeric code.

Turn on the DOQQ. Since this was the NW DOQQ it covers the NW section of the Walla Walla (O46118a1) DRG.

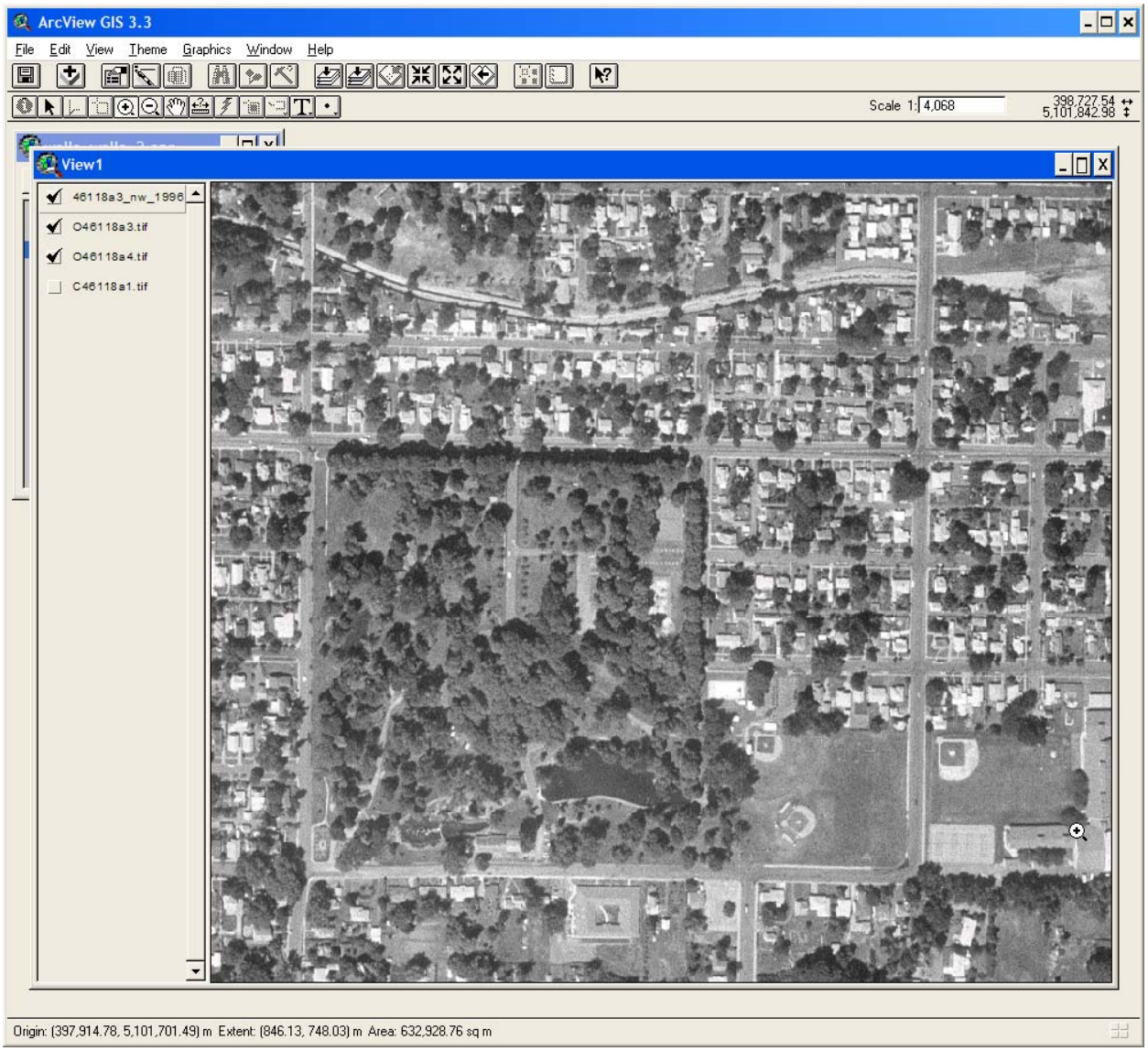


7. Explore detail in the DOQQ

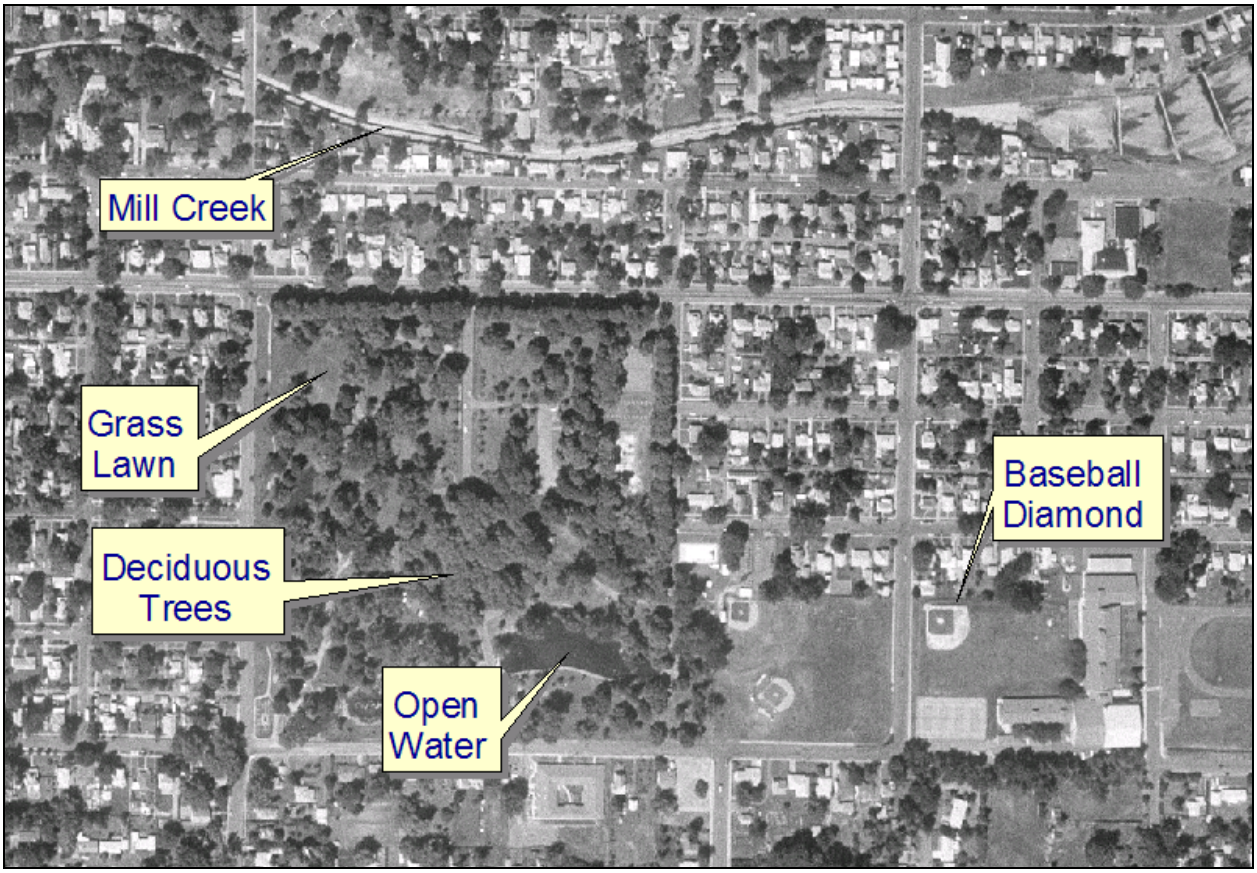
Zoom to the area indicated by the red arrow in the figure below.



A Digital Orthophoto Quandrangle gives a view that conveys a large amount of information about the land surface. Black and white (panchromatic) images provide numerous clues include shape, texture, shadow, tone, and context that help users identify land surface features.



Many features in DOQ's are intuitively identifiable. Familiarity with urban land use tells us that this portion of the DOQ is of a residential area with some small commercial and institutional buildings. The arrangement and size of the streets relative to buildings is the primary clue. With careful study, specific land cover types such as roofs, street pavement, sidewalks, lawns, and open water can be distinguished. Turn off the DOQ layer and look at the underlying 24K DRG. The DRG text indicates this is residential area near Pioneer Park and Pioneer Junior High School.



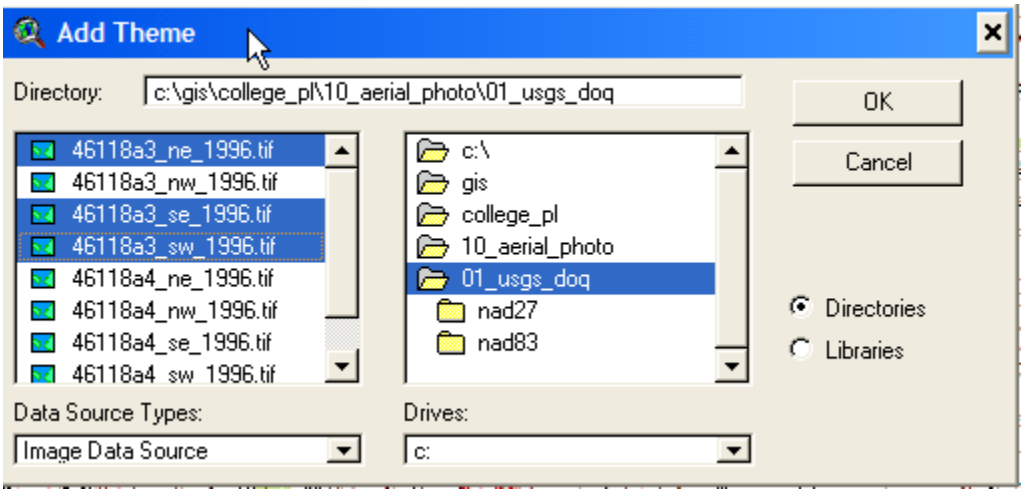
Pan to Mill Creek in the top part of the view window. Can you identify the unusual features within the stream channel to the right side (east) of the bridge? It is helpful to know that the original aerial photo was acquired on July 1, 1996. Water is very low in the stream channel. Water typically looks dark compared to exposed streambed material. Five linear structures cross the stream channel at relatively close spacing. Each appears to be holding back a small amount of water. Since the backed-up water covers a small area it appears that these structures do not extend very far above the stream bed. These structures are probably designed to spread and slow the stream during higher flow to help control bed erosion and lateral channel movement.

Portions of the stream channel below the bridge are dewatered. The presence of some water in the thalweg indicates that this stream is not completely dry and is likely conveying some subsurface flow.

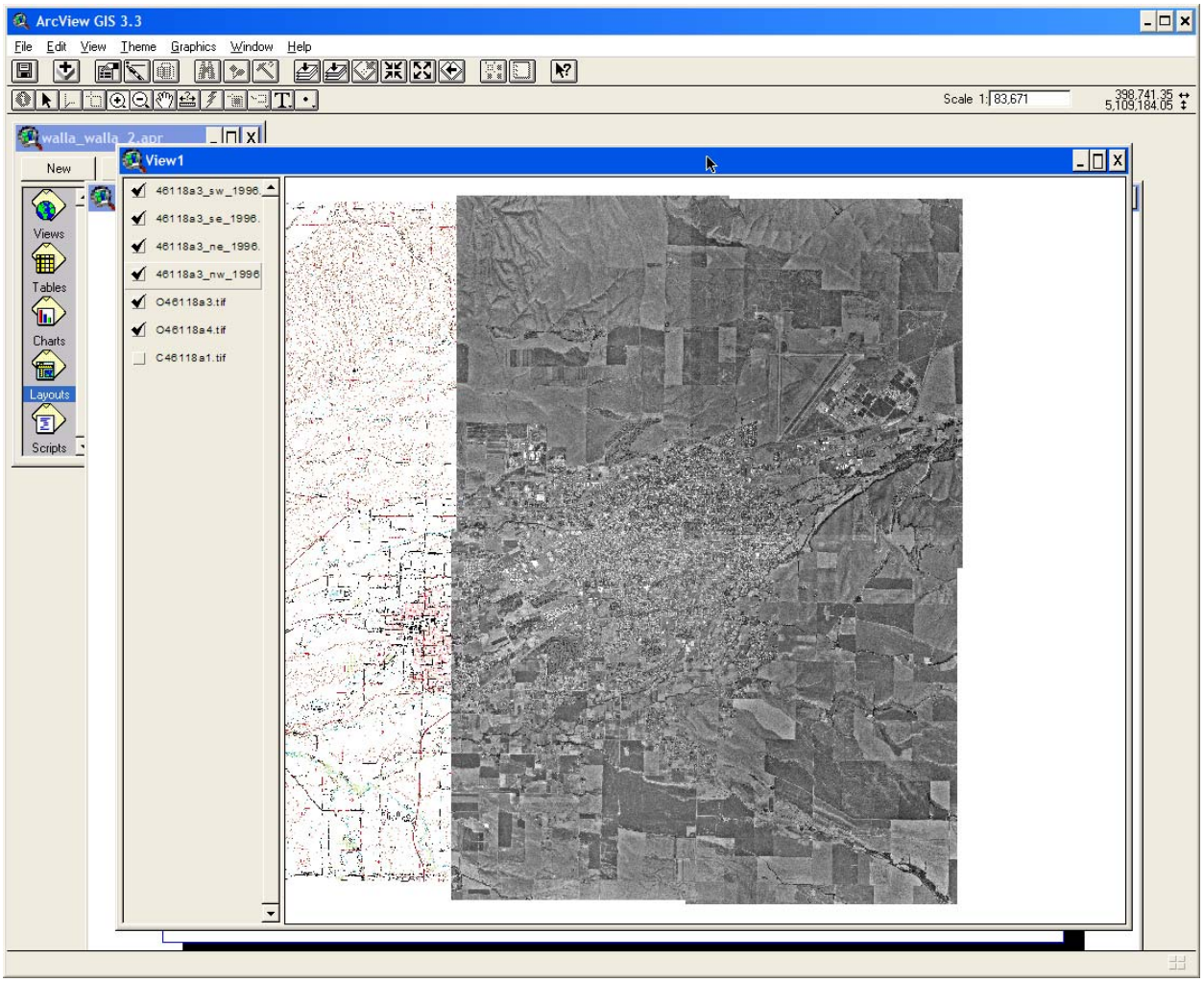
Turn off the DOQQ and examine the 24K DRG. Limits of stream channels on DRG's usually depict normal water levels. It is good to know this when using DRG's to collect information about stream channels. DOQ's provide much more detail about the physical characteristics of streams than can be included in a single topographic map. Though DOQ's show streams at a single point in time, when combined with other sources of information such as stream discharge and channel elevation data they can help develop a good model of hydrologic response.

8. A DOQQ Mosaic

Click the add theme button and select the other three DOQQ's that cover the Walla Walla DRG.



Turn on each of the DOQQ's. Zoom to the extents of the DRG layer to display all the DOQQ's. Zoom and pan around the four images to become familiar with the coverage area. For help in identifying features, toggle off the DOQQ images to observe the symbols and text information on the DRG.



1.

Exercise

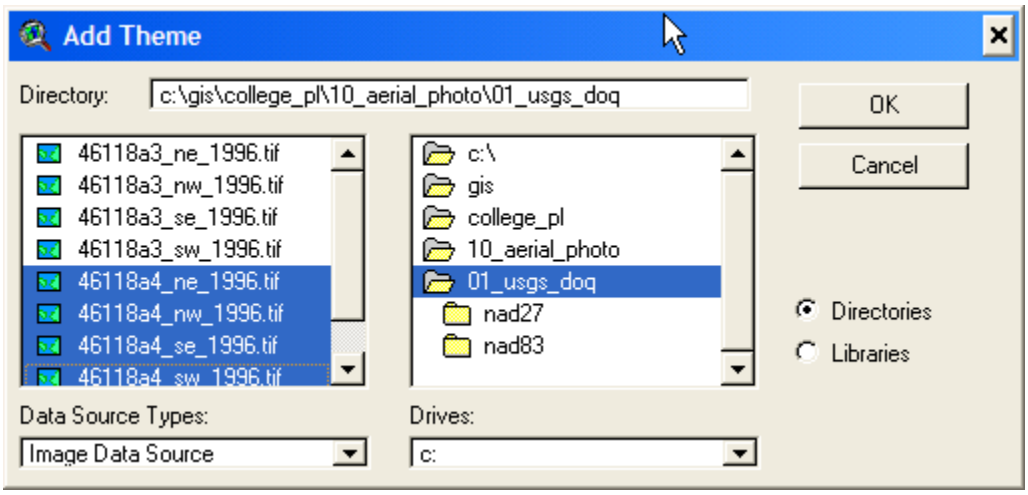
Identify the features at the following coordinate locations

Point	East Coordinate	North Coordinate	Feature
1	401,493	5,105,644	
2	402,571	5,101,891	
3	397,350	5,099,584	
4	396,256	5,100,444	
5	395,442	5,100,318	
6	394,084	5,100,965	
7	393,796	5,101,935	
8	394,563	5,102,206	
9	396,658	5,103,136	
10	397,404	5,096,816	
11	397,037	5,096,670	
12	395,431	5,106,904	
13	394,941	5,103,624	
14	395,447	5,102,813	

(Answers at the end of the tutorial)

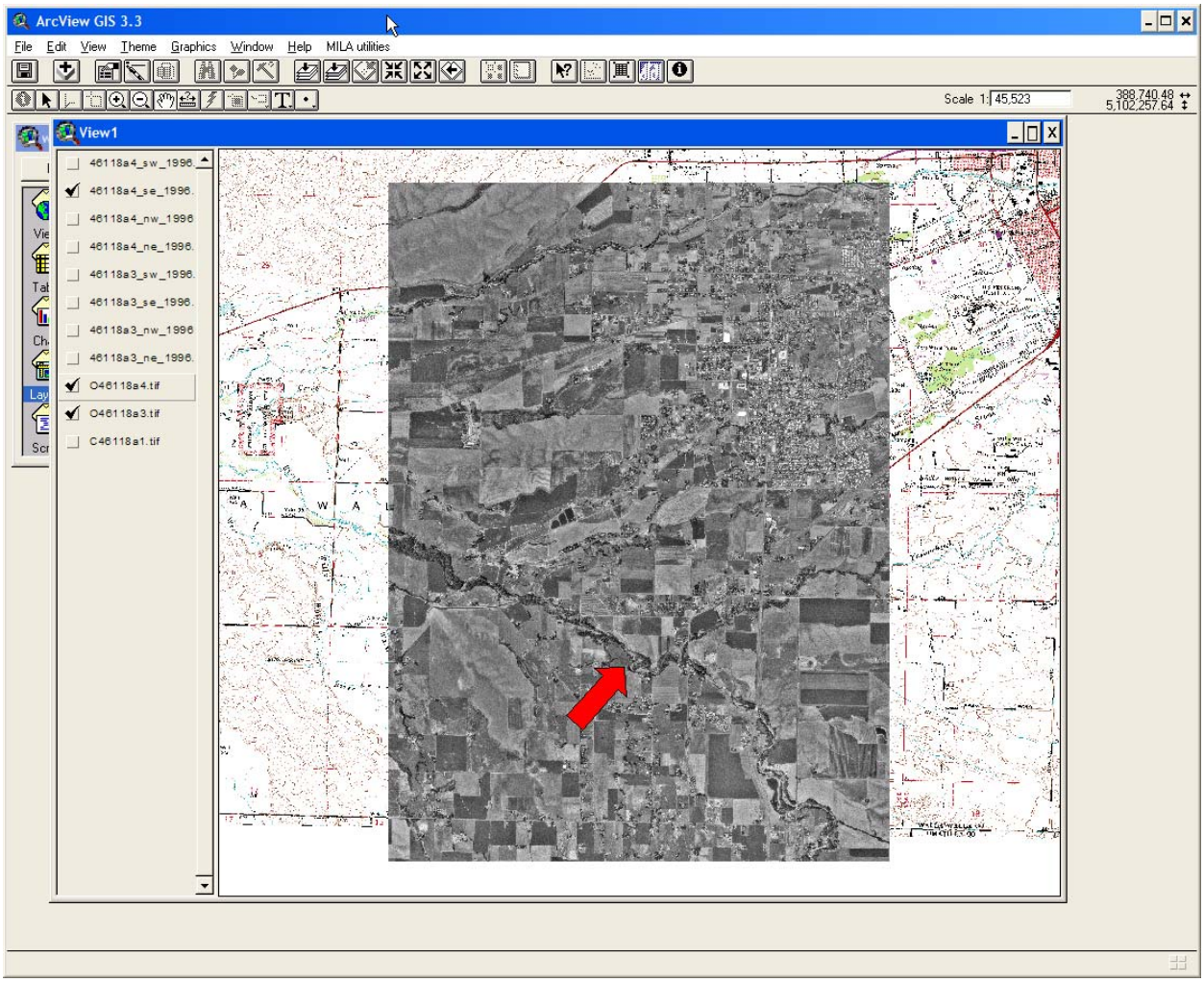
9. Load the College Place DOQQ's

Click the Add Theme button and navigate and load the four DOQQ's for the College Place quadrangle. Hold down the shift key to select multiple files.



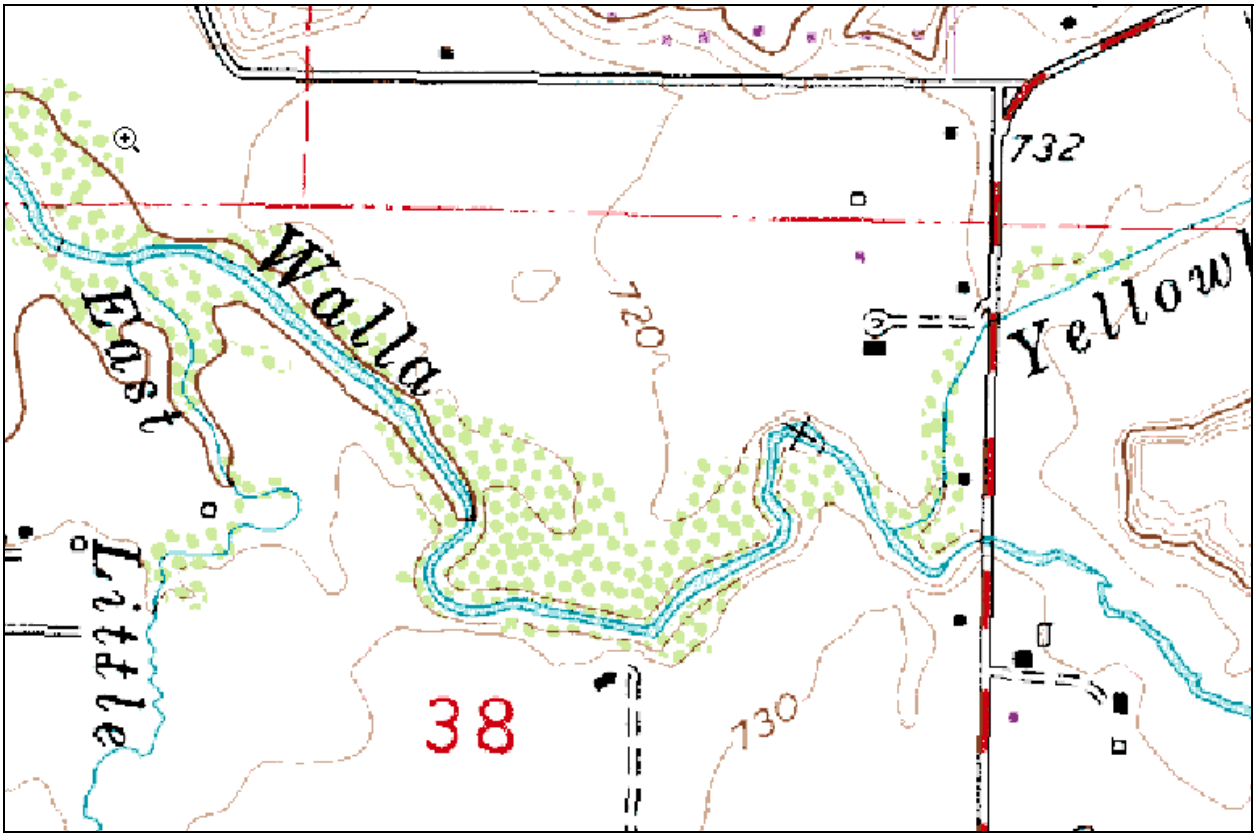
10. Stream Channel Change

Turn off all DOQQ's except 46118a4_se_1996.tif. Zoom to the extents of 46118a4_se_1996.tif. The Walla Walla River crosses the lower portion of the DOQQ, flowing northwest (red arrow). We'll compare the location of the river channel in the 1996 DOQQ with the historic channel shown in the 24K DRG. Zoom to the location indicated by the red arrow in the figure below.

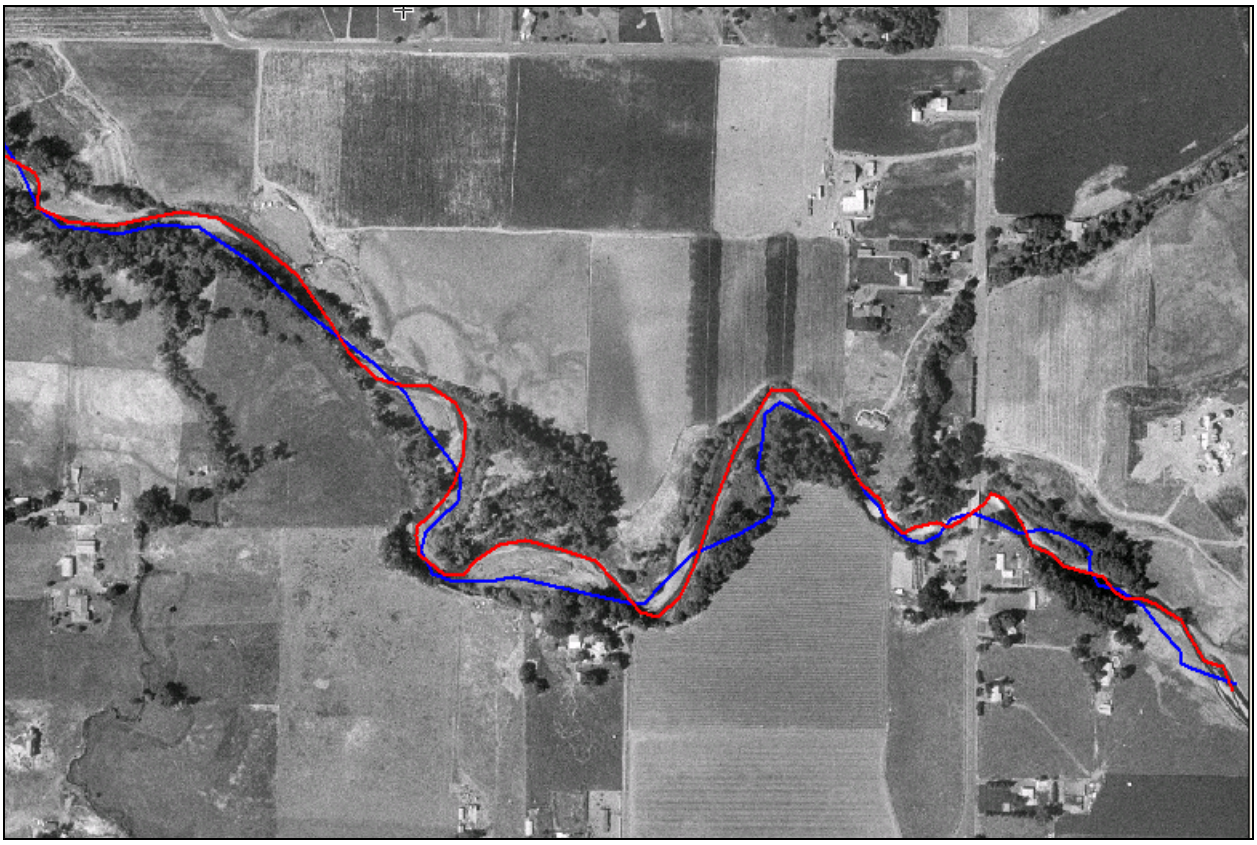


Differences in soil type and moisture may cause tone variation in aerial images. Alluvial materials deposited by streams may be different enough from surrounding soils to show evidence of historic river channels. Multiple historic river channels are seen near the red arrow in figure below.

Turn off the DOQQ to see the underlying DRG. The DRG was last revised with aerial photography acquired in 1976. The stream channel has shifted at several locations between 1976 and 1996. Toggle the DOQQ on and off to more clearly see the channel change.



Centerlines of the 1996 channel (red) is compared to the 1976 channel (blue) are shown in figure below. The length of the 1976 channel centerline is 2150 meters and the 1996 channel is 2250 meters long. The digitized stream centerlines were digitized and recorded as polyline themes. Temporary stream length measurements can be made with the graphics tool or measurement tool .

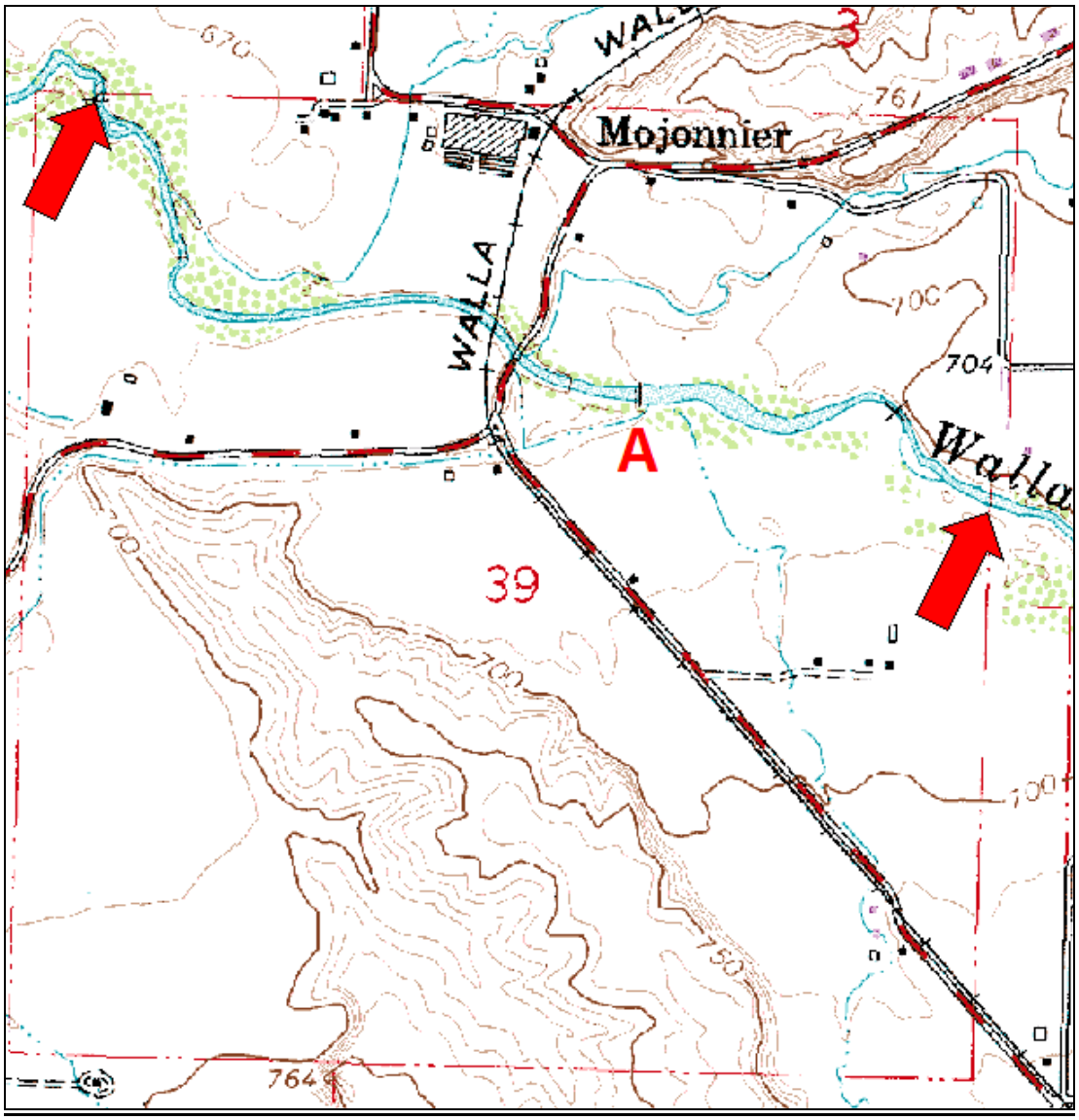


2.

Exercise

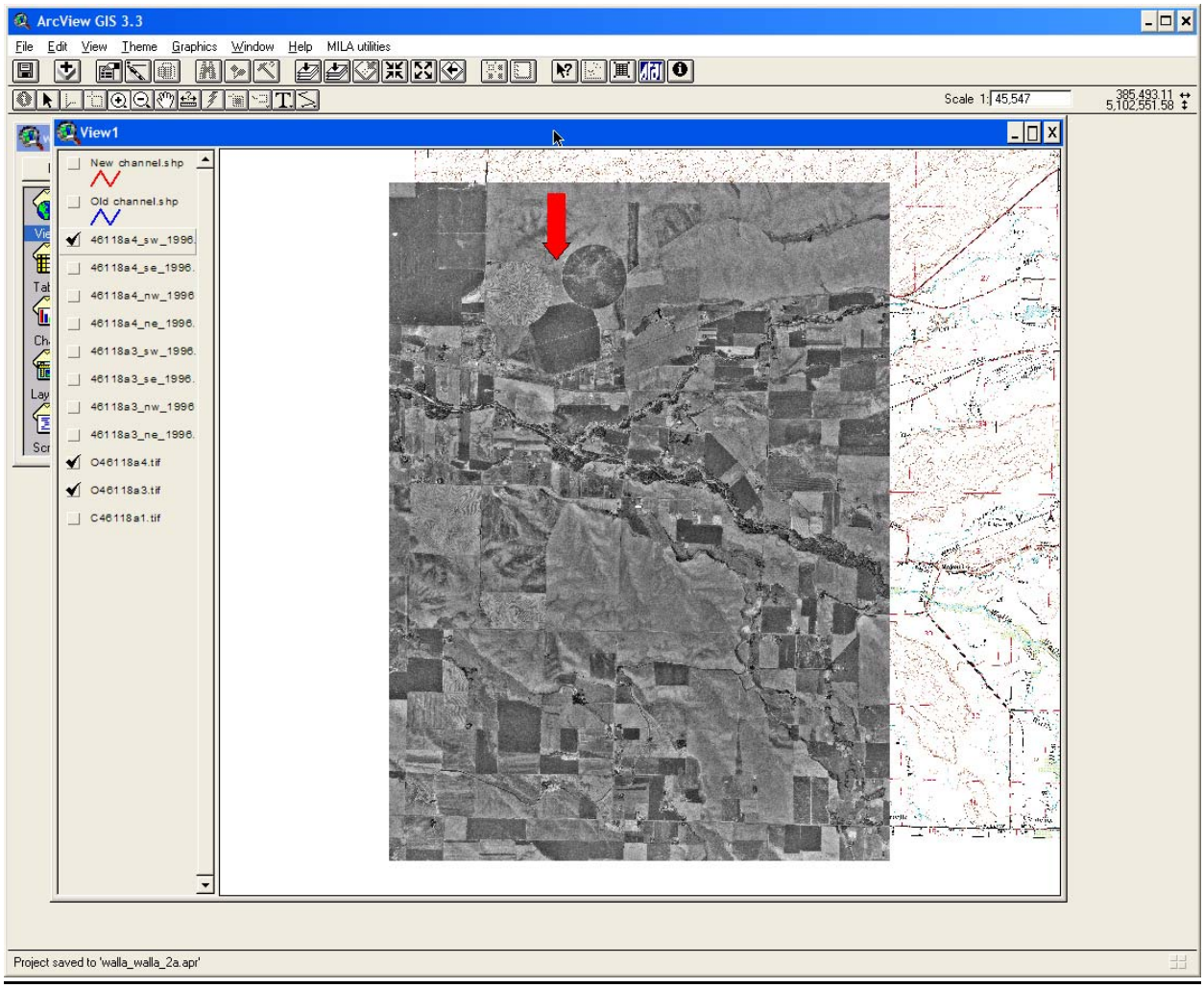
Create polyline graphics or themes to compare the position and length of the Walla Walla River channel in 1976 and 1996 for the reach that passes through Section 39 of the College Place quadrangle. What is the structure in the channel at A?

1976 Length _____ 1996 Length _____



11. Land Use/Land Cover Classification

Land cover types and land uses may often be interpreted directly from DOQ's. In previous steps we recognized urban/suburban land use as a mix of pavement, building, lawn and park land cover. Many agricultural land cover types and uses are also readily distinguished. Turn on the SW DOQQ of the College Place quadrangle. Zoom to the area indicated by the red arrow in the figure below.



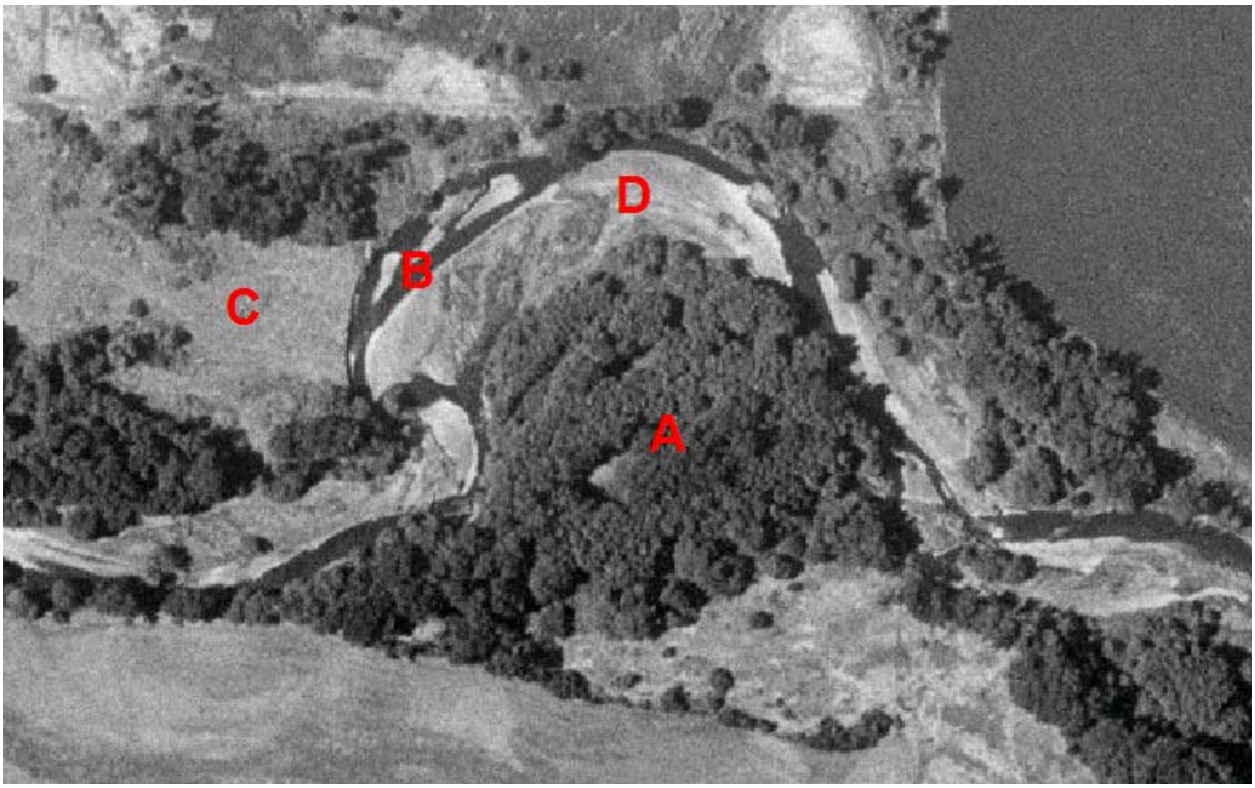
Irrigated agricultural lands may often be distinguished from non-irrigated fields by shape and distinctive cropping patterns, such as these center pivot irrigated fields. Supporting data such as digital elevation models can help identify areas suitable for irrigation and provide further evidence of probable land use.

The moiré pattern in the field on the right in the figure above is an artifact of the way that computer screens display concentric patterns at reduced resolution. A closer zoom below reveals the circular pattern characteristic of center pivot irrigation.

The agricultural fields labeled A, B, and C are located along Dry Creek in the NW DOQQ of the College Place quadrangle. Cropping patterns indicate that fields A and B are irrigated at least a part of the growing season. Field C on higher and steeper terrain is a nonirrigated field.

A lack of distinctive cropping patterns or signs of surface disturbance often indicate natural terrain or conservation areas such as field A in the Whitman Mission National Historical Site. B and C are both agricultural fields. The pond north of A is readily identified by its shape and uniform dark tone. Clear water is characteristically very dark in black and white (panchromatic) aerial photography.

Land cover in riparian zones may be a mix of natural and cultural features. The tone and texture of the vegetation at A indicates these are deciduous trees and shrubs, probably cottonwoods and willows growing in the less disturbed areas of the Walla Walla River floodplain south of the Whitman Mission. In channel features such as the mid channel gravel bar at B often lack vegetation because of periodic disturbance by high flows. Area D appears to be covered by grass and low growing shrubs, while Area C appears to be relatively stable floodplain pasture. With careful study and appropriate aerial imagery, vegetation form and channel patterns can reveal the recent morphological history of riparian zones.



SUMMARY

Aerial images record a large amount of geospatial detail of land surface. Distortion inherent in source aerial photographs can be corrected to produced map-like digital images. Digital Orthophoto Quandrangle (DOQ's) produced by USGS are a useful and cost effective source of geospatial detail for Geographic Information Systems (GIS). This tutorial introduced the USGS Digital Orthophoto Quadrangles of the area near Walla Walla and developed skills locating and identifying land surface features.

Answers to Exercises

1. Answer:

Point	East Coordinate	North Coordinate	Feature
1	401,493	5,105,644	Airport, Runways 20 and 25
2	402,571	5,101,891	Mill Creek Lake
3	397,350	5,099,584	Cemetary
4	396,256	5,100,444	Fair grounds
5	395,442	5,100,318	Trailer park
6	394,084	5,100,965	Shopping mall and parking lot
7	393,796	5,101,935	Wastewater treatment plant
8	394,563	5,102,206	Stream grade control structure
9	396,658	5,103,136	Running track
10	397,404	5,096,816	Cottonwood Creek channel
11	397,037	5,096,670	Irrigated agricultural field
12	395,431	5,106,904	Nonirrigated agricultural fiel
13	394,941	5,103,624	Penitentiary
14	395,447	5,102,813	Railroad yard with box cars

2. Answer:

1976 Length is 1920 meters. 1996 length is 2003 meters

The structure at A is a small irrigation diversion dam. An irrigation canal flows west from this dam.